



## Subject card

Subject name and code	Separation Techniques, PG_00037492						
Field of study	Biotechnology						
Date of commencement of studies	October 2020	Academic year of realisation of subject				2022/2023	
Education level	first-cycle studies	Subject group				Optional subject group Subject group related to scientific research in the field of study	
Mode of study	Full-time studies	Mode of delivery				at the university	
Year of study	3	Language of instruction				Polish	
Semester of study	6	ECTS credits				2.0	
Learning profile	general academic profile	Assessment form				exam	
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry						
Name and surname of lecturer (lecturers)	Subject supervisor						
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	15.0	0.0	0.0	45
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours		Self-study	SUM
	Number of study hours	45		3.0		2.0	50
Subject objectives	Knowing the techniques for separating mixtures						
Learning outcomes	Course outcome	Subject outcome			Method of verification		
	K6_U09	the student is able to apply basic chromatographic and spectroscopic methods, as well as the more important separation methods used in biotechnology			[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		
	K6_W09	Students will be familiar with the specification of separation problems in biotechnology, technology and related fields - mixtures of gases, liquids, granular solids in the gas, liquid phase.			[SW1] Assessment of factual knowledge		

Subject contents	<p>Lecture</p> <ul style="list-style-type: none"> <li>- Specification of separation / enrichment / purification problems in biotechnology, drug technology and biotechnology and food technology and biotechnology and related fields - mixtures of gases, liquids, granular solids in the gas / liquid phase;</li> <li>- Specification and general characterisation of separation, purification operations for isolation of components / groups of components of mixtures on a scale from analytical, through preparative, to process;</li> <li>- Breakdowns of sample / batch preparation techniques and methods for enrichment and separation of mixtures;</li> <li>- Measurement / quality control methods in separation;</li> <li>- Multistage separation operations in the practice of obtaining usable quantities of pure product; Principles of selecting the optimum separation route depending on the separation problem, the purity required and the form of the final product;</li> <li>- General principles of scaling up separation operations;</li> <li>- Principles and laws governing separation in terms of thermodynamics, kinetics, hydrodynamics and dispersion. Theoretical fundamentals of hydrodynamic, thermodynamic, diffusion, distillation, absorption, adsorption, membrane, electrochemical and electro-migration operations, precipitation (precipitation), complexation, drying, lyophilisation, including, simultaneous mass and heat transfer operations relevant to separation. Issues of flow resistance, mass dispersion, process kinetics, degree of deviation from equilibrium. Principles for the design of so-called operational lines in rectification, absorption and adsorption;</li> <li>- Preparatory and auxiliary operations - grinding, milling, dissolution, homogenisation, evaporation, including, gas jet evaporation with freeze-thawing, freeze-drying, steam distillation;</li> <li>- Separation techniques and methods - precipitation, complexation, etc. for separation of biotechnology products, pharmaceuticals, food additives ;</li> <li>- Hydrodynamic techniques using sieving, sedimentation, filtration, fluidisation and elutriation, centrifugal forces, mass transfer through solid and liquid membranes, surface activity phenomena including: filtration and pseudo-filtration (longitudinal filtration) batch and continuous, sedimentation, decantation, elutriation, cyclone / hydrocyclone, centrifugation / ultracentrifugation, coagulation, flotation, micro-, ultra-, nano-filtration, etc. operations and interactions - fundamentals, scopes of application...;</li> <li>- Periodic and continuous single and multi-stage extraction, its applications in sample preparation, chemical and refinery/petrochemical technology; Gas extraction in purification from volatile components;</li> <li>- Frontal / elution techniques and methods for sorption and chromatography in gas-solid and gas-liquid (GC), liquid-solid , liquid-liquid (SPE, LC, HPLC) systems, i.e., partitioning / adsorption / ion exchange / exclusion techniques in the separation of complex mixtures - theoretical basis of adsorption and chromatography; Partitioning and characterisation of adsorbents, adsorbents, ion exchangers;</li> <li>- Modern high-performance (HPLC) and ultra-high-performance (UPC / UPLC) sorption and chromatography techniques - mechanisms of retention and selectivity under linearity of sorption isotherms (no column overloading), ranges of application: <ul style="list-style-type: none"> <li>-- High-performance liquid chromatography of exclusion (GPC-SEC) under lipophilic / hydrophilic conditions; Chromatography of exclusion in the determination of molecular weight distribution / preparation of low-dispersion polymer fractions / desalting / preparation of samples with a specific molecular weight range / determination of components / component groups of mixtures;</li> <li>-- Chromatography in reversed-phase (RP), normal-phase (NP), hydrophilic interaction conditions (HILIC);</li> </ul> </li> </ul> <p>Key techniques and detection methods in sorption / liquid chromatography conditions : UV-VIS/DAD, RID, FLD, LC-MS;</p> <ul style="list-style-type: none"> <li>- Ion exchange and i</li> </ul> <p>Laboratory exercises include</p> <ol style="list-style-type: none"> <li>1. casein precipitation techniques and solid-liquid separation to obtain whey - precipitation at specific pH using different acids for this purpose, followed by - membrane cross-filtration / sedimentation and decantation after acidic / thermal casein shearing / centrifugation; Group separation of whey components with reference to standards of selected components; Molecular weight separation of mixtures of components and lipophilic component groups : <ul style="list-style-type: none"> <li>- Precip.; Purification of whey / extracts / lye - Purification; Thin layer TLC chromatography under NP / RP / HILIC conditions; High performance exclusion chromatography under hydrophilic conditions - HPLC-GPC-SEC-hydrophil. - EBF/RID/UV-VIS-DAD; High performance exclusion chromatography under lipophilic conditions - HPLC-GPC-SEC-lipophilic. - EBF / RID/UV-VIS-DAD. - mixtures of lipid standards, plant metabolites (carotenes / chlorophylls / carotenoids).</li> </ul> </li> <li>2. Gradient elution separation Grad-HPLC-RP / HPLC -HILIC-UV-VIS-DAD model column scale separation of whey components without and with standards with fraction collection; Isocr-HPLC-NP-UV-VIS-DAD/RID - with isocratic elution and eluent reflux - EBF / metabolite separation with fraction collection; Columns: RP: C18-100, RP 300SW, Phenyl-100, CN-100; HILIC: NH2 - 100 / 300, CN-100, DIOL 100/1000, SiO2 - 100 / 250, ZrO2-DIOL - GF250, ZIC-HILIC; NP: SiO2-60/100, DIOL 100, NH2 - 100, CN -100.</li> <li>3. Isocratic / gradient ion exchange chromatography IExC - SCX (SA) / SAX (SB); Hydrophobic interaction chromatography HIC; Ion exclusion chromatography IExIC- whey components and whey component standards ;</li> <li>4. filling of preparative / semi-preparative HPLC / PLC column by "wet" / "dry" techniques - Wyp; Testing the performance of the prepared columns TEST - in terms of permeability, porosity, efficiency, retention and selectivity and assessing the suitability of the column for preparative scale use;</li> <li>5. use of model-based, semi-preparative, preparative HPLC / PLC columns for group/"detailed" separation of whey components in the absence and with overloading of a P-LC/P-HPLC column with fraction collection; . Control of composition and purity of selected eluate fractions at analytical scale HPLC / TLC - KJ;on exchange chromatography (IExC) and ion chromatography (IC); Conductometric detection; Ion suppression;</li> </ol>									
Prerequisites and co-requisites	It is necessary for students to know and understand the basics of physics, physical chemistry, general chemistry, inorganic and organic chemistry, chemical engineering and general technology before starting this subject. A reminder of the key principles of the aforementioned subjects is recommended. For students with a weak knowledge of physics and physical chemistry, a refresher course in the aforementioned subjects is recommended prior to the study of Separation Techniques.									
Assessment methods and criteria	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 33%;">Subject passing criteria</th> <th style="width: 33%;">Passing threshold</th> <th style="width: 33%;">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td>laboratory</td> <td>60.0%</td> <td>40.0%</td> </tr> <tr> <td>exam</td> <td>60.0%</td> <td>60.0%</td> </tr> </tbody> </table>	Subject passing criteria	Passing threshold	Percentage of the final grade	laboratory	60.0%	40.0%	exam	60.0%	60.0%
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Recommended reading	Basic literature	<p><b>I. Materiały pomocnicze dla Studentów</b> na stronie domowej Katedry Inżynierii Chemicznej i Procesowej - kierunek studiów: Biotechnologia, przedmiot Techniki Rozdzielania Mieszanin, Instrukcje laboratoryjne</p> <p>- <a href="http://www.pg.gda.pl/chem/Katedry/Inzynieria/index.php/pl/mat/bt/trm">http://www.pg.gda.pl/chem/Katedry/Inzynieria/index.php/pl/mat/bt/trm</a></p> <p><b>II. Literatura istniejąca w bibliotece WCh-PG</b> : 1. M. Serwiński, Operacje jednostkowe w inżynierii chemicznej, WNT, Wa-wa, (dowolne wydanie); 2. A. Selecki, L. Gradoń, Podstawowe procesy przemysłu chemicznego, WNT, Wa-wa, 1985., 3. M. Kamiński, Chromatografia cieczowa [red.], CEEAM, Gdańsk 2004; 4. Z. Witkiewicz, Podstawy chromatografii, WN-T, Warszawa 2000; 2005; 5. R. Rautenbach, Procesy Membranowe, WNT, Warszawa, 1996;</p>
	Supplementary literature	<p>1. S. Ciborowski, Inżynieria Chemiczna, WNT Wa-wa, (dowolne wydanie); 2. R. Rosset, H. Kołodziejczyk, Współczesna chromatografia cieczowa, WN-T, Warszawa, 2001; 3. A. Narębska [red.], Membrany i membranowe techniki rozdzielania, Wyd. UMK, Toruń, 1997; 4. M. Berek, M. Dressler, M. Kubin, K. Marcinka, Chromatografia żelowa, PWN, W-wa, 1989.</p>
	eResources addresses	
Example issues/ example questions/ tasks being completed	In accordance with the subject matter.	
Work placement	Not applicable	